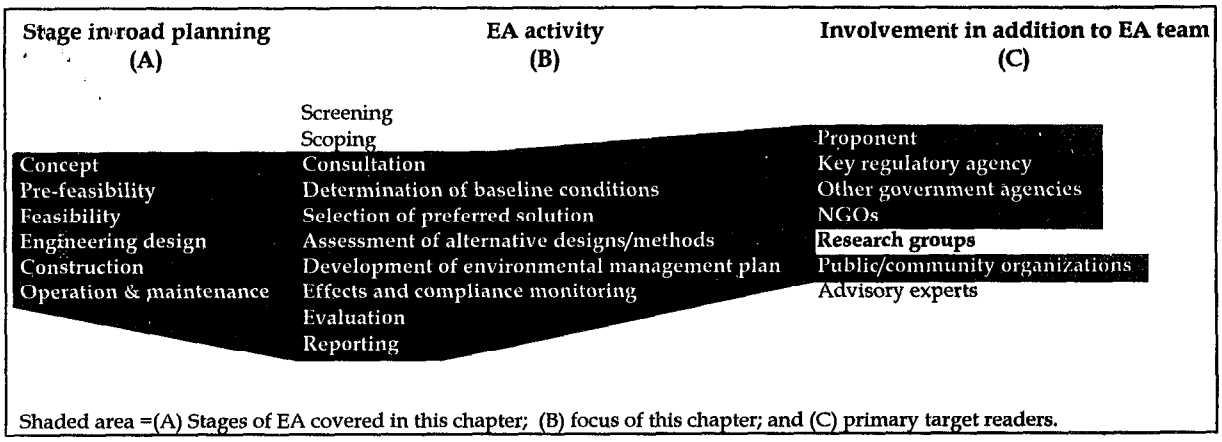
17. Impacts on human health and safety

HOW TO USE THIS CHAPTER IN THE CONTEXT OF EA AND ROAD PLANNING



Shaded area =(A) Stages of EA covered in this chapter; (B) focus of this chapter; and (C) primary target readers.

KEY QUESTIONS ADDRESSED:

- In what ways can road development hasten the spread of disease?
- What are the special considerations for non-motorized transport?
- Which sectors of government should be responsible for promoting accident prevention and road safety?
- How can education and thoughtful design reduce the negative impacts of road development on human health and safety?

Improved travel for motorized traffic may come at the expense of other road users, such as these women carrying water in India

17.1 IMPACTS AND SETTING

Nowhere is impact prevention more important than in the area of road safety and human health. Poor planning can lead to loss of life, which can neither be mitigated nor adequately compensated.

Road projects often have serious negative consequences for the health of local populations. By encouraging direct contact between previously disparate areas, roads provide ideal corridors for the transmission of disease between humans, and from plants and animals to humans. It is also likely that some form of air or water pollution will occur as a result of road development, further endangering the health of people living near the new development.

Safety is an issue that must be addressed as well, since road accidents result in deaths, injuries, and damage to property. They are a major public health problem and a significant cost to the economy in many parts of the world. While accident rates have been falling in many of the more developed countries, they are increasing in other countries where the road systems, travel speeds, and level of motorization are still growing.

Pedestrians and non-motorized vehicles are the most vulnerable users of roads, and are at greater risk of being injured in accidents. In areas where these road users mix with motorized traffic, special measures must be adopted to prevent the increased mobility of motorists from undermining the safety and health of all other road users.

17.2 DETERMINING THE NATURE AND SCALE OF IMPACTS

17.2.1 Human health

Road development may be instrumental in the decline in health of a local population in several ways. It can

- facilitate the transmission of diseases;
- contaminate the local water supply (see Chapter 8);
- pollute the air (Chapter 9); and
- become a source of noise pollution (as discussed in Chapter 16).

Disease transmission

Disease transmission is facilitated by the migration of people, which invariably accompanies road projects. Work crews—as well as the relatives and dependents who usually follow them—may bring with them a multitude of communicable diseases including diphtheria, poliomyelitis, tetanus, and malaria. Their temporary camps, often characterized by standing water and poor waste management practices, provide the ideal conditions for vermin, and other vectors of disease, to multiply and infect the local human population. At the same time, it is possible that a disease endemic to the project area will be contracted by the work crew, and then transmitted to a population near the next work site (see Box 17.1).

BOX 17.1
ROADS AND THE SPREAD OF STDs

Throughout the world, the spread of AIDS and other sexually transmitted diseases (STDs) can be linked to the construction of roads and the resultant opening-up of new regions. Although there are no empirical data to support this theory, it is believed that migrant populations—particularly truck drivers and construction workers—whose mobility is enhanced by new road projects are the most likely vectors for these diseases. The spread of STDs in brothels along some highways, for example, was probably hastened by the migrant population that regularly used that road (and its 'services'). This particular impact of road construction can only be mitigated through education of both the migrant and local populations.

TABLE 17.1
VEHICLE EMISSION COMPONENTS AND THEIR HEALTH EFFECTS

Pollutant	*Health effects*
Carbon monoxide (CO)	Reduces the ability of the blood to carry oxygen. Symptoms of exposure include headaches, vertigo, impaired mental function, aggravated cardiovascular disease, and impaired fetal development. In strong doses, fatal asphyxiation.
Oxides of nitrogen (NO_x)	Aggravate and induce respiratory and cardiovascular afflictions such as asthma, emphysema, tuberculosis and bronchitis.
Hydrocarbons (HC)	Contribute to eye, nose and throat irritation. Benzene is a known carcinogen.
Aldehydes	Eye, throat, and lung irritation. In some cases, allergic reactions.
Particulates	Eye and respiratory irritation, aggravation of asthma. Some are suspected carcinogens.
Lead (Pb)	Nervous disorders, impaired mental function, and behavior problems, especially in children. Also anemia, possibly brain damage.
Sulphur dioxide (SO_2)	Aggravates respiratory ailments such as asthma, bronchitis, and emphysema.

Source: Adapted from Clapham, 1981; Lee, 1985.

It is useful to consult statistics from international agencies, such as the World Health Organization, to determine the geographic distribution of communicable diseases that are most often transmitted by work crews and other highly mobile populations. This information can be combined with reports from local health authorities about the incidence of these diseases, to find out whether the road crews might bring different strains of a disease, or completely new diseases, to an area.

Water supply contamination

Water supply contamination often occurs when an influx of people—associated with the road project—overloads the local sanitation infrastructure, and encourages the spread of waterborne diseases such as amoebic dysentery, typhoid and cholera.

Where the local population uses surface water for drinking, concerns about polluted run-off from the road (Chapter 8), and road accidents involving vehicles carrying hazardous materials (Section 18.4.1) must be addressed.

"Casual" water

In the tropics "casual" standing water, created by road projects, presents a considerable health hazard, since it provides breeding habitat for snails, flies and mosquitos. On a World Bank project in the Sub-Saharan region, it was found that more bilharzia transmission resulted from puddles on road maintenance projects than from irrigation canals (Listori, 1995). Moreover, abandoned tires, old barrels, and cans provided more fly and mosquito breeding habitat than did nearby natural and irrigation water bodies (Listori, 1995).

Air pollution

Air pollution becomes a health problem when the road in question is heavily used by motorized traffic and where there are dense settlements alongside the project. Table 17.1 gives an overview of the health risks associated with chronic exposure to motor vehicle emissions.

In areas where food crops are grown adjacent to a heavily-traveled road, project planners and local residents should be aware that concentrations of heavy metals might be found in

roadside plants. This type of contamination is a serious health hazard, since it can taint the entire food chain, and needs to be addressed.

17.2.2 Road safety

There are many features of a road and its surroundings which influence the risk of a road accident or the severity of accidents when they do occur. Examples of these features[1] include

- pavement and shoulder condition;
- the presence of roadside poles, trees, ditches, steep slopes, and barriers;
- signs, markings, intersection layout and control;
- roadside access, parking, and bus stop arrangements; and
- provisions for pedestrians, cyclists, and other non-motorized road users (Box 17.2).

At a national level, accident exposure is often measured by accident rates (fatalities, injuries, and accident numbers), and is related to the number of vehicles registered or vehicle-kilometers traveled. Since the number of fatalities and the number of vehicles comprise the most readily available statistics, the ratio of deaths per 10,000 vehicles on register is often used; accidents per 100,000 population is also a commonly-used statistic.

At the project level, local information on accident history may identify unsafe locations on existing roads. Examination of similar projects could identify potential problems associated with road improvements, such as increased speed through built-up areas, lack of pedestrian crossing facilities, and inadequate allocation of road space for non-motorized vehicles. Examination of the connections between improved and existing roads may highlight possible hazards at new intersections and inconsistencies in road standards which might not be recognized by drivers.

Accident reporting systems are essential for identifying accident "blackspots" where physical improvements are most likely to be successful. Further information can identify

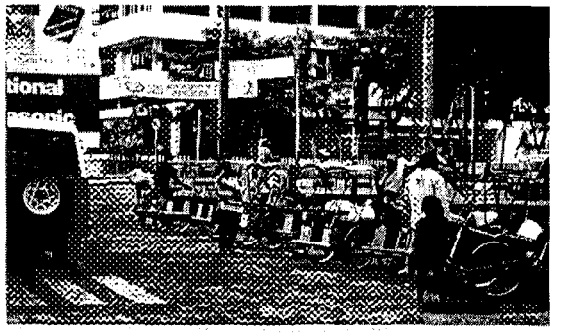
- the types of people affected (i.e. pedestrians, motorcyclists, car occupants);
- the types of accidents (i.e. head-on or right-angle collisions, single vehicles leaving the road); and
- the types of locations (i.e. intersections, curves, or divided roads).

This information is usually recorded by police attending accidents, and its quality and synthesis depend on coordination, management, and training efforts.

Analysis of accident data is essential in ensuring that remedial measures are well targeted and effective. This requires specialized skills and knowledge and should be used both to identify critical problems and to test the results of past safety efforts.

Within the parameters of road safety, the possibility of landslides must also be examined (see Box 7.1). Unstable cuts above a road, or below, if the road collapses, can prove fatal to road users who happen to be in the wrong place at the wrong time.

Traditional modes of transport, like these cycle taxis in Indonesia need roadside space at key urban locations



17.3 REMEDIAL MEASURES

17.3.1 Prevention

Health

The prevention of major outbreaks of disease can be accomplished through a comprehensive health awareness campaign, carried out in conjunction with a road project. Successful awareness programs include preventive measures such as immunizing the vulnerable population, and educating people about diseases

[1] Transport and road research Laboratory *(1991)* contains a useful guide for evaluating and improving road safety, using these types of features as indicators

BOX 17.2
EXAMPLES OF MITIGATIVE MEASURES FOR PEDESTRIAN AND NON-MOTORIZED VEHICLE ACCIDENT BLACKSPOTS

Activities
- walking or traveling along the road in the direction of, or toward traffic
- crossing the road
- standing on or by the road

Accident "blackspot" associated with
- negligent crossing or walking
- undefined crossing sites
- narrow road
- low quality shoulder surface
- poor visibility
- high speed
- rushing into the roadway
- lack of non-motorized lanes/paths
- disjointed bicycle network

Mitigative measures

Improvement of pedestrian and cyclist facilities
- widening or construction of shoulders
- construction of separate lanes and paths
- provision of non-motorized-only streets
- painting of edgelines in order to separate shoulders
- construction of exclusive bridges for non-motorized road users
- provision of traffic signals with phases for bicyclists
- establishment of non-motorized vehicle waiting area
- temporal separation by limiting the entry of motorized or non-motorized vehicles

Speed-limiting measures
- provision of speed limit signs for non-motorized vehicles
- construction of humps to reduce speed of motorized vehicles in narrow streets
- active police enforcement of speed limits

Improvement of visibility
- parking prohibition
- removal of sight limiting obstacles, plants, etc.
- construction of cycle-rickshaw waiting area within street parking
- installation of lighting (especially of crossing sites)
- use of liths and non-motorized vehicle reflectors

Limiting of non-motorized vehicle movements by fences or guardrails

Improvement of crossing sites
- (re)painting of zebra crossing and provide signs
- provision of line of reflective studs on both sides of zebra crossing
- construction of raised zebra crossing (with warning signs)
- construction of level-separated crossing

Regulations, education, and safety awareness training

(including STDs); how they are contracted, and how to avoid them by using treated water, practicing "safe sex," and keeping living areas cleaner. Spraying incoming and outgoing vehicles, as well as screening and treating affected local and migrant populations are two measures which may also be effective in controlling the movement of disease vectors (through contaminated water and between people).

The negative impacts of localized air pollution on human health can be prevented by choosing road alignments which avoid human settlements. The prevention of air pollution itself is discussed in Chapter 9.

Casual water

There is a startlingly high correlation between increases in endemic tropical diseases such as malaria and bilharzia and casual waters at construction sites (Listori, 1995). The best preventive measure is to prepare a site management plan which explicitly focuses on the elimination of casual water through "good housekeeping" practices.

Safety

There is no doubt that accident prevention is more valuable than any mitigative or compensatory measure. Its effectiveness will depend on cooperation amongst, and actions taken by, the various groups which are directly and indirectly involved with the road project.

Proper design of road safety features is a very effective way to prevent accidents. Planners and contractors involved with the design of the road should

- examine road design standards, safety equipment specifications and training to ensure that design details take account of safety concerns and that specific safety features are correctly designed and installed;
- require that road design audits be done, at preliminary and final design stages, by specialists in road safety and traffic operations; and
- draft traffic management plans, including details of signs, markings, intersection layouts, channelization of flows, access restrictions, footpaths, bus stops, and provisions for non-motorized vehicles.[2]

Road safety and accident prevention are also the responsibility of the ministries and agencies which regulate the transportation network. Effecting national policy changes is beyond the scope of the project-level environmental assessment, but it may be a feasible goal when doing sectoral EAs for national or regional road development schemes. In some jurisdictions, road safety councils have already been established to evaluate and recommend the adoption of road safety policies such as

- mandatory use of seat belts;
- compulsory driver training and testing;
- prohibition and punishment of driving while impaired by drugs or alcohol;
- traffic safety education for children; and
- testing and inspection of all vehicles according to national vehicle safety standards.

If this type of centralized institution does not exist, then it is the responsibility of the road project proponents to advocate the creation of a road safety council or at least to promote similar safety standards on each project.

Road councils, with the help of their member agencies and ministries, are also obligated to develop national or regional road safety plans, which might include

- ensuring that post-accident emergency assistance and medical care are available to all accident victims;
- developing an accurate accident data recording system;
- conducting research and regularly monitoring the state of road safety;
- determining the need for further road improvements (based on accident data); and
- encouraging research and development of new, safety-oriented road technologies.

The development of a safety council requires a long-term commitment to institution building, training, and funding, but it is an option that should not be overlooked. The data and statistical information assembled by a centralized body can be very useful for devising successful mitigation programs in the future (see Chapter 2 for further discussion of institution building).

Safety and non-motorized vehicles (NMVs)

It is particularly important at this stage to look at impact prevention for the more vulnerable road users—pedestrians, cyclists, animals, rickshaws, etc.—since they can become a major source of traffic congestion and are involved in a higher number of accidents. For every road improvement that allows more motorists to travel faster, there should be a parallel improvement in road safety features for non-motorized vehicles, such as

- NMV lanes physically separated from motorized traffic by barriers or designated by pavement markings;
- shoulder improvements;
- NMV paths within an independent right-of-way;
- streets on which motorized vehicles are banned;
- bicycle parking lots; and
- waiting areas (for example for cycle-rickshaws).

[2] These should be incorporated into road designs, while separate traffic plans for managment of traffic during construction and maintenance should be the responsibility of the construction contractors (see Chapter 18).

The construction of exclusive facilities is the most effective approach in the minimization of safety impacts on non-motorized vehicles. Physical separation with barriers usually provides better protection than pavement markings, but in many cases the roadway is too narrow for constructing exclusive lanes or paths. If this is the case, a shoulder of at least 1.5 to 2.0 meters should be provided so that NMVs can travel safely, without slowing the motorized traffic flow. If the shoulder is used for non-motorized vehicle travel, adequate pavement strength must be maintained. If the pavement used for shoulders is not strong enough, it quickly deteriorates with use, and easily develops potholes—a condition that makes travel difficult and dangerous for slow-moving vehicles such as bicycles or rickshaws. Such shoulder conditions may cause non-motorized users to use the main roadway instead, thereby negating any positive effect that may have resulted from the separation of motorized and non-motorized vehicles.

Pedestrian facilities such as sidewalks, zebra crossings, and pedestrian bridges improve the flow and safety of vehicular traffic, particularly in urban and near-urban areas. However, if they are improperly designed or congested by street vendors or illegal settlements, these safety features can be so inconvenient that people will choose a more dangerous route just to shorten their journey. (See Chapter 11 for a discussion on roads and community severance.)

Where there is a high concentration of bicycles and rickshaws, off-street parking and special waiting areas can reduce traffic congestion and accidents between motorized and non-motorized vehicles.

It is important to emphasize that improvements benefiting motorized road users are not always positive for non-motorized users, and any roadwork should be carefully assessed for its impact on the safety of pedestrians and NMVs.

17.3.2 Mitigation

Health

Measures to mitigate negative impacts on water quality and disease transmission are similar to the preventive measures discussed earlier in this chapter. For example, if the spread of disease among the local people and road crews is not prevented, an epidemic can be avoided by encouraging 'good health' practices through education. If the work-site is identified as the source of the problem, the contractors should be obliged to keep it clean and provide adequate sanitation facilities for the workers and their families. Potable water should also be supplied to all households in the short term to prevent further infection of the population. (Section 8.3 discusses remedial measures for water contaminated as a result of road run-off.)

Health impacts from severe air pollution are difficult to mitigate in the short-term; however, in the long-term, action should be taken to prevent inhalation of airborne contaminants. Such action might include planting dense stands of vegetation along the road to filter dust and other pollutants, or increasing the distance between the road and the people, either by moving the road or resettling the people. These mitigative measures are discussed further in Chapter 9.

Safety

If accident prevention is not a priority on a road project, then mitigative measures will almost certainly be necessary. Road safety councils are useful sources of information at this stage if they have been properly set up for data collection. The development of 'blackspot' programs, which set aside funds for low cost improvements targeting known high-accident locations, is a common mitigative measure (Box 17.2). To undertake this type of program, it is important that there be evidence of actual accident history at the proposed site. Furthermore, any mitigative measures should have a history of effectiveness, be based on a rigorous analysis of expected benefits, and include a follow-up program for monitoring the accident blackspot after the improvements have been made. All of this data is more reliable if it has been assembled by a centralized and standardized body such as a road safety council.

The provision of rest areas on heavily traveled highways is also important for ensuring the safety of all road users. These allow drivers to leave the busy road safely, rest, and use toilet facilities. Rest areas are also an excellent place for drivers to check the condition of their

vehicles. Frequent checks are especially important for trucks, since a brake failure or tire blowout on a large truck can be extremely dangerous, and potentially fatal, for other users of the road.

Road users who are involved in a disproportionate number of accidents, such as pedestrians and non-motorized vehicles, should be included in special safety programs which teach people proper traffic safety, and funds should be provided for new physical road safety features to protect them.

17.3.3 Compensation

Individuals who have contracted a disease, been injured, or died as a result of contact with a road project cannot receive adequate compensation. Instead, compensation should benefit the entire community. For example, the provision or improvement of community health services could compensate for the increased risks associated with living on or near a road.

17.4 AVOIDING IMPACTS ON HUMAN HEALTH AND SAFETY: AN ACTION CHECKLIST

Road projects have the potential to drastically degrade the health and safety of local residents if developed or managed incorrectly. This section highlights the more important steps in the EA process which consider and incorporate health and safety concerns in road planning and development.

Baseline data and potential impacts
Accident data and geographic distribution of communicable diseases should be reviewed and analyzed to predict and identify trends, hazardous locations, and groups at greatest risk. Health and safety problems are not the same in all countries, and particular attention should be given to local accident experience, and incidence of certain diseases.

Analysis of alternatives
Consider safety and health consequences, and whether a parallel awareness program would be necessary with each alternative alignment. Consider using accident blackspot remedial measures as an element of road improvement projects.

Mitigation plan
Review design standards and the need for training in safety-conscious design principles. Take adequate precautions to prevent the spread of disease and promote health awareness.

Environmental specifications for contractors
These should cover correct practices for installation of safety features such as guardrails, culvert end-walls, and road signs, as well as traffic safety requirements for the operation of work zones and construction traffic. Enforce 'good housekeeping' practices on work sites and in crew camps.

Legislation, policies and national programs
Laws, regulations, and enforcement related to speed, alcohol, and vehicle safety should be reviewed, beginning with those aspects under the direct control of the road agency directly responsible for the road project (for example speed zoning, road signs). In the long term, road safety programs, policies, regulations, and priorities need to be coordinated with other agencies in the framework of comprehensive safety action plans. Nation-wide awareness campaigns about the threat of communicable and vector-borne diseases associated with a more mobile population should be implemented. Legislation can be used to control air and water contamination by contractors in particular. Hygiene and health education could become part of local school curricula.

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